PBEEEP
State Government

Public Buildings Enhanced Energy Efficiency Program

SCREENING RESULTS FOR STATE CAPITOL

Admin Minnesota
DEPARTMENT OF ADMINISTRATION

June 9, 2011

Summary Table

State Capitol Building	
Location	75 Constitution Ave, Saint Paul, MN 55101
Facility Manager	Gordon Specht
Number of Buildings	1
Interior Square Footage	378,825
PBEEEP Provider	Center for Energy and Environment (Gustav Brändström)
State's Project Manager	Harvey Jaeger
Date Visited	January 11, 2011
Annual Energy Cost (from B3)	$413,525 (2010)
Utility Company	District Energy St. Paul (Hot and Chilled Water), Xcel Energy (Natural Gas and Electricity)
Site Energy Use Index (from B3)	58.4 kBtu/sq ft (2010)
Benchmark EUI (from B3)	102.4 kBtu/sq ft

The Minnesota State Capitol is a four story building built in 1905. It houses the Governor's Office, House of Representatives, the Senate, and many offices. There are also many large public spaces and a cafeteria.

Screening Overview

The goal of screening is to select buildings where an in-depth energy investigation can be performed to identify energy savings opportunities that will generate savings with a relatively short (1 to 5 years) and certain payback. The screening of the State Capitol Building was performed by the Center for Energy and Environment (CEE) with the assistance of the facility staff. A walk-through was conducted on January 11, 2011 and interviews with the facility staff were carried out to fully explore the status of the energy consuming equipment and their potential for recommissioning. This report is the result of that information.

Recommendation

A detailed investigation of the energy usage and energy savings opportunities of the State Capitol Building is not recommended at this time. The floor area listed in the table has not been verified.

Building Name	State ID	Square Footage	Year Built
State Capitol Building	G0231010062	378,825	1905

There are many factors that are part of the decision to recommend an energy investigation of a building; at the State Capitol Building some of the characteristics that would indicate the building is a good candidate for recommissioning are:

- Large square footage
- Level of control by the building automation system
- Equipment size and quantity
- Support from the staff and management to include building in an investigation

Although the building staff are clearly supportive of an energy investigation and would like to further reduce energy use at their facility, the energy use at the site is simply too low for a recommissioning study to be certain of delivering cost- effective savings. Recommissioning is focused on low-cost and no-cost measures that typically involve control changes and other minor adjustments to equipment operation. The Energy Use Index (EUI) for the State Capitol Building is 58 kBtu/sq ft. This is a very low EUI and indicates that the staff has already identified the majority of short payback items. In addition, the staff has already implemented many good ideas, and continue to pursue others to reduce their energy consumption.

Potential Energy Reduction Measures and Existing Problems

Although the building is not a good candidate for an energy investigation, there were some potential measures and existing problems identified during the screening that may result in energy savings if resolved. The building staff is aware of these issues and they are listed below:

- Most terminal units are pneumatically controlled and therefore do not report back to the main AHUs on space temperatures. With better control of the terminal units, better control of the AHUs is possible.
- The spaces seemed very warm during the walk-through, a 20°F day, and it could quite possibly be because of the lack of automation in the spaces. The additional controls would make temperature setpoints global and night setbacks would be possible.
- The exhaust fans, and associated MAUs if applicable, are very expensive to run when AHUs are not operating since it produces uncontrolled infiltration. The fans should only be run whenever necessary.
- The outside air temperature sensor for the building BAS seems to be out of calibration. The weather station in St Paul says it was 37°F outside while the BAS says 31°F. This difference really makes a difference when it comes to heating and cooling lockouts, and for economizer operation.

Mechanical Equipment

There are a total of 26 air handlers located throughout the building. Most of the air handlers are constant volume, but there are some Variable Air Volume (VAV) AHUs. The air handlers use hot water, chilled water, and humidification to condition the air. There are an unknown number of pneumatic VAV boxes with HW reheat in the spaces.

The heating and cooling of the building is supplied by district energy and the heating water is isolated from the Capitol Campus loop by heat exchangers. The Plant Management Department regulates when hot water and chilled water is available to the buildings on the Capitol Campus.

There are many exhaust fans of varying size, from 235 cfm to 18,000 cfm, which serve mainly electrical and mechanical rooms, and bathrooms. Two units serve the kitchen and are connected to a Makeup Air Unit.

The following table lists the key mechanical equipment in the Minnesota State Capitol.

Mechanical Equipment Summary Table	
Quantity	**Equipment Description**
1	Honeywell EBI Automation System
1	Building
378,825	Interior Square Feet
26	Air Handlers
Unknown	VAV Boxes (The pneumatic VAVs are not on BAS and number is unknown)
23	Hot Water Pumps
3	Chilled Water Pumps
12+	Exhaust Fans (there are 12 EFs on the BAS, but more EFs in the spaces)
500	Approximate number of points for trending

Controls and Trending

The building runs on a Honeywell EBI R310.1 Building Automation System (BAS), which is part of the State Capitol Complex system. The Plant Management Division (PMD) of the Department of Administration controls the BAS.

Lighting

The majority of interior lighting is 32 Watt T8s. Most spaces are operated by manual switches. There are a great number of special historical lights and special use lights that are not easily retrofitted with lighting that is more efficient.

Energy Use Index and B3 Benchmark

The site Energy Use Index (EUI) is 58 kBtu/sq ft. This is 43% lower than the B3 Benchmark of 102 kBtu/sq ft. The median site EUI for State of Minnesota buildings are 23% lower than their corresponding B3 Benchmarks. This indicates that the State Capitol Building does not have much potential to further reduce its energy use as other State buildings.

Metering

The State Capitol Building has one electric, one hot water, one chilled water, and one natural gas meter. The district energy meters are used by Plant Management to bill for the HW and CHW use in the building.

Documentation

There is a significant amount of mechanical documentation, including building plans, equipment schedules, operations and maintenance manuals, and control sequences available on-site.

Building Summary Table

The following tables are based on information gathered from interviews with facility staff, a building walk-through, automation system screen-captures, and equipment documentation. The purpose of the tables is to provide the size and quantity of equipment and the level of control present in each building. It is complete and accurate to the best of our knowledge.

State Capitol State ID# G0231010462					
Area (sq ft)	378,825	Year Built	1905	EUI/Benchmark	58.4 / 102.4
HVAC Equipment					

Air Handlers (26 Total)

Description	Type	Size	Notes
S-1	CV	SF 4,930 CFM,5 HP	Serves Basement center 8
S-1B	CV	SF 5 HP RF 2 HP	Serves Room G-15. Has DX Cooling
S2	CV	SF 1,200 CFM, .75 HP	Serves G Flr NE
S3	VAV	SF 10,553 CFM, 15 HP	Serves 2nd & 3rd Flr East Wing North
S4	VAV	SF 8,304 CFM, 10 HP RF 5HP	Serves G and 1st Flr East Wing North
S5	VAV	SF 10,970 CFM, 10 HP RF 8,800 CFM	Serves G and 1st Flr East Wing South
S5A	CV	SF 5,466 CFM, 5 HP	Serves B East Wing South
S6	CV	SF 19,289 CFM, 20 HP RF 7.5 HP	Serves 2nd & 3rd Flr East Wing South
S7	CV	SF 4,200 CFM,2HP	Serves Rotunda G, 1st, & 2nd Flr West
S8	CV	SF 4,200 CFM, 2 HP	Serves Rotunda G, 1st, & 2nd Flr East
S9	CV	SF 14,376 CFM, 20 HP RF 7.5 HP	Serves B and 1st Flr West Wing North
S10	VAV	SF 5,108 CFM,5 HP RF 3,950 CFM, 1.5 HP	Serves 2nd & 3rd Flr West Wing North
S11	VAV	SF 10,915 CFM, 20 HP RF 5 HP	Serves B & 1st Flr West Wing South
S12	VAV	SF 5,725 CFM, 5 HP RF 4,580 CFM, 2 HP	Serves 2nd and 3rd Flr West Wing South
S13	CV	SF 4,950 CFM,5 HP RF 3HP	Serves 2nd, 3rd, and 4th Flr North
S14	CV	SF 6,240CFM, 15 HP RF 6,240 CFM, 7.5 HP	Serves B West Wing, B to 5th Flr, and Security
S15	CV	SF 3,000 CFM, 3 HP	Serves Room B-46 and B-44
S17	CV	SF 1.5 HP	Serves Janitorial Office
S18	CV	SF 11,339 CFM,20 HP RF 17,000 CFM, 7.5 HP	Serves House Chambers & Retiring Rooms
S19	CV	SF 11,193 CFM,15 HP RF 5 HP	Serves Senate Chambers & Retiring Rooms
S21	VAV	SF 10,308 CFM, 15 HP RF 4,714 CFM, 3 HP	Serves Cafeteria
S22	VAV	3,945 CFM,3 HP	Serves Senate Office North
S23	CV	3,200 CFM, 3 HP	Serves Senate West Hearing Room 107

HVAC Equipment (Continued)

Air Handlers continued

Description	Type	Size	Notes
S24	CV	3,100 CFM, 3 HP	Serves Senate East Hearing Room 112
S25	CV	0.15 HP	Serves House Skylights
S26	VAV	4,000CFM, 7.5 HP	Serves Room G-10 Senate Media

Cooling Unit

Description	Type	Size	Notes
Liebert	CRAC	10 Tons	

Humidifying Boiler

Description	Type	Size	Notes
	Electric	120 kW	

Exhaust Fans (Unknown Total)

Description	Type	Size	Notes
EF-1, 7, 15, 16, 17, 20, 21, 30		Unknown	No plans or listing for EFs. There are 12 units on the BAS

VAV Boxes (Unknown Total)

Description	Notes
	An unknown number of VAV boxes exist in the Capitol. Most boxes are pneumatic and are not on the BAS. There are 5 DDC VAVs in the cafeteria that is on the BAS.

Hot Water Pumps (23 Total)

Description	Type	Size	Notes
P1A	Heating Pump	400 gpm, 7.5 hp	Primary Heating Pumps
P1B	Heating Pump	400 gpm, 7.5 hp	
P5A	Heating Pump	120 gpm, 3 hp	Secondary Radiation
P5B	Heating Pump	120 gpm, 3 hp	
P7A	Heating Pump	23 gpm, 0.5 hp	AHU S-14 Reheat
P7B	Heating Pump	23 gpm, 0.5 hp	
P8	Heating Pump	0.75 hp	Serves North Wing East Rad.
P10A	Heating Pump	80 gpm,3 hp	East Wing Secondary Loop
P10B	Heating Pump	80 gpm, 3 hp	
P12A	Heating Pump	175 gpm, 5 hp	House Area Reheats
P12B	Heating Pump	175 gpm, 5 hp	
P17A	Heating Pump	70 gpm, 3 hp	West Wing North Sec. loop
P17B	Heating Pump	70 gpm, 3 hp	
P21A	Heating Pump	70 gpm,2 hp	AHU S-21
P21B	Heating Pump	70 gpm, 2 hp	
P22A	Heating Pump	80 gpm, 3 hp	West Wing South Rad. And FCs
P22B	Heating Pump	80 gpm, 3 hp	
P30	Heating Pump	22 gpm, 0.25 hp	AHU S-17 Reheats
P36	Heating Pump	0.5 hp	Secondary Reheats
P37R	Heating Pump	0.25 hp	North Wing Radiation
P37	Heating Pump	0.33 hp	UHs and AHU S-16
P38	Heating Pump	0.25 hp	AHU S-15 Reheats
P39	Heating Pump	92 W	NE Entrance. Not on BAS.

Points on BAS

Air Handlers

Description	Points
S-1	OA Damper Pos, RAT, RA RH and Setpoint, RA Damper Pos, Min OA Damper Pos Setpoint, OA Damper Pos, MAT and Setpoint, SF-S, Cooling Valve Pos, Humidifier output, Economizer Lockout Temp, DAT and Setpoint.
S-1b	OA Damper Pos, MAT, DX Status, Cooling Valve Pos, SF-S, DAT, Room Temp and Setpoint
S-2	RAT, RARH and Setpoint, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Heating Valve Pos, Cooling Valve Pos, SF-S, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint
S-3, S-4,	RAT, RARH and Setpoint, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S and Speed, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint, DSP and Setpoint, Room Temp
S-5a	Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S, Economizer Lockout Temp, DAT and Setpoint
S-6	RAT, RARH and Setpoint, RF-S, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Heating Valve, Cooling Valve Pos, SF-S, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint
S-7, S-8	Cooling Valve Pos, SF-S, DAT
S-9	Min OA Damper Setpoint, Damper Pos, MAT and Setpoint, Economizer Lockout Temp, RAT, RARH and Setpoint, F&BP Damper, Cooling Valve Pos, SF-S, RF-S, DAT and Setpoint, Humidifier Output
S-10, S-11, S-12, S-5	RAT, RARH and Setpoint, RF Speed, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S and Speed, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint, DSP and Setpoint, Room Temp
S-13	RAT, RARH and Setpoint, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint, Room Temp
S-14, S-18, S-19	RAT, RARH and Setpoint, RF-S, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint, Room Temp
S-15	Min OA Damper Setpoint, Damper Pos, MAT and Setpoint, Economizer Lockout Temp, RAT, RARH and Setpoint, F&BP Damper, Cooling Valve Pos, SF-S, DAT and Setpoint, Humidifier Output
S-16	Relief Damper Pos, RA Damper Pos, OA Damper Pos, Min OA Damper Setpoint, Economizer Lockout Temp, RAT and Setpoint, RF-S, MAT and Setpoint, Heating Valve Pos, Cooling Valve Pos, RARH, SF-S, EF 31-S, Room Temp, Humidifier Output, DARH and Setpoint, Winter and Summer DARH Setpoint, S/W Changeover Setpoint
S-17	Min OA Damper Setpoint, Damper Pos, MAT and Setpoint, Economizer Lockout Temp, RAT, Cooling Valve Pos, SF-S, DAT and Setpoint
S-20	SF-S
S-21	Min OA Damper Setpoint, Damper Pos, MAT, Economizer Lockout Temp, RAT, RF-S, F&BP Damper, Cooling Valve Pos, Heating Valve Pos, SF-S and Speed, DAT and Setpoint, DSP and Setpoint
S-22	RAT, RARH and Setpoint, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S and Speed, DSP and Setpoint, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint, Room Temp (2X)

Points on BAS Cont'd

Air Handlers

Description	Points
S-23, S-24	RAT, RARH and Setpoint, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Heating Valve Pos, Cooling Valve Pos, SF-S, Humidifier Output, Economizer Lockout Temp, DAT and Setpoint, Room Temp
S-25	OA Air Damper Pos, SF-S
S-26	RARH and Setpoint and Reset, RAT, RF-S and Speed, EF-S and Speed, EF Damper Pos, Min OA Damper Setpoint, OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S and Speed, DSP and Setpoint, DA-RH and Hi-Limit Setpoint, DAT and Setpoint, Zone Damper Pos (3X), Studio ZN-T and Setpoint, Vestibule ZN-T and Setpoint, Control Room ZN-T and Setpoint, Studio Modes, Economizer Lockout Temp, Humidifier Status and Output
S-27, S-28	OA Damper Pos, MAT and Setpoint, Cooling Valve Pos, SF-S, DAT and Setpoint, Room Temp

VAV

Description	Points
VAV	Box Flow and Setpoint, Damper Pos, Heating Valve Pos, Room Temp and Setpoint

CHW System

Description	Points
CHW	Capitol Loop: CHWST, CHWRT and Setpoint, Valve Pos and Setpoint Building Loop: CHWP Status and Speed (2X), Pump By-Pass Valve Pos, CHW DP and Setpoint, Booster Pump Status (3X)

Hot Water System

Description	Points
HW	Capitol Loop: HWRT, Valve Pos Building Loop: HWST, Setpoint and Reset Schedule, HWRT, HWP-S (2X)

Lighting System

Description	Points
Misc Lights	Status

Exhaust Fans

EF-1, 7, 15, 16, 17, 20, 21, 30	Status
Kitchen EF 31, 32	Status

Misc

Description	Points
Hum. Boiler B-56 and B-9	Status
Compressors B9, B10, B46D	Status

Pumps

Description	Points
HWP 30, 10A, 10B, 36, 38, 12A, 12B,22A,22B, 37R, 37, 17A, 17B, 5A, 5B, 8, 21A, 21B, 7A, 7B	Pumps Status

PBEEEP Abbreviation Descriptions			
AHU	Air Handling Unit	HUH	Horizontal Unit Heater
BAS	Building Automation System	HRU	Heat Recovery Unit
CD	Cold Deck	HW	Hot Water
CDW	Condenser Water	HWDP	Hot Water Differential Pressure
CDWRT	Condenser Water Return Temperature	HWP	Hot Water Pump
CDWST	Condenser Water Supply Temp	HWRT	Hot Water Return Temperature
CFM	Cubic Feet per Minute	HWST	Hot Water Supply Temperature
CHW	Chilled Water	HX	Heat Exchanger
CHWRT	Chilled Water Return Temperature	kW	Kilowatt
CHWDP	Chilled Water Differential Pressure	kWh	Kilowatt-hour
CHWP	Chilled Water Pump	MA	Mixed Air
CHWST	Chilled Water Supply Temperature	MA Enth	Mixed Air Enthalpy
CRAC	Computer Room Air Conditioner	MARH	Mixed Air Relative Humidity
CUH	Cabinet Unit Heater	MAT	Mixed Air Temperature
CV	Constant Volume	MAU	Make-up Air Unit
DA	Discharge Air	OA	Outside Air
DA Enth	Discharge Air Enthalpy	OA Enth	Outside Air Enthalpy
DARH	Discharge Air Relative Humidity	OARH	Outside Air Relative Humidity
DAT	Discharge Air Temperature	OAT	Outside Air Temperature
DDC	Direct Digital Control	Occ	Occupied
DP	Differential Pressure	PTAC	Packaged Terminal Air Conditioner
DSP	Duct Static Pressure	RA	Return Air
DX	Direct Expansion	RA Enth	Return Air Enthalpy
EA	Exhaust Air	RARH	Return Air Relative Humidity
EAT	Exhaust Air Temperature	RAT	Return Air Temperature
Econ	Economizer	RF	Return Fan
EF	Exhaust Fan	RH	Relative Humidity
Enth	Enthalpy	RTU	Rooftop Unit
ERU	Energy Recovery Unit	SF	Supply Fan
FCU	Fan Coil Unit	Unocc	Unoccupied
FPVAV	Fan Powered VAV	UH	Unit Heater
FTR	Fin Tube Radiation	VAV	Variable Air Volume
GPM	Gallons per Minute	VFD	Variable Frequency Drive
HD	Hot Deck	VIGV	Variable Inlet Guide Vanes
HP	Horsepower	VUH	Vertical Unit Heater

Conversions:
1 kWh = 3.412 kBtu
1 Therm = 100 kBtu
1 kBtu/hr = 1 MBH